OCR GCSE GATEWAY CHEMISTRY A · J248

CHEMISTRY



EXAM QUESTION PACK

C5.2 CONTROLLING REACTIONS

SCORE	PERCENTAGE
/217	%

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Gateway Chemistry A (9-1)

Controlling reactions

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

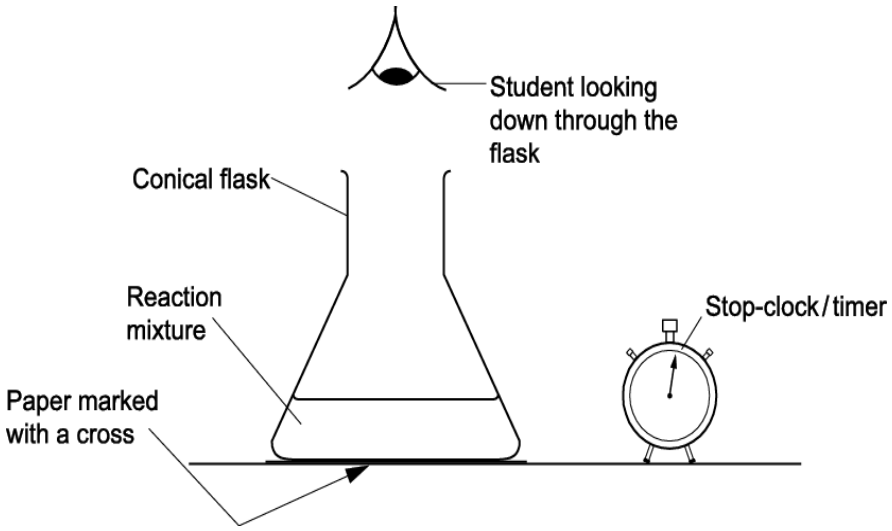
- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **217**.
- The total number of marks may take into account some 'either/or' question choices.

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1 A student investigates the reaction between sodium thiosulfate and hydrochloric acid.
Look at the diagram below. It shows the apparatus he uses.



After a time he cannot see the cross because the liquid in the beaker goes cloudy. The student measures the time taken until the cross cannot be seen.

He does the experiment four times, each with a different concentration of sodium thiosulfate solution.

Which of the following must **not** be changed to do a fair test?

A concentration of sodium thiosulfate used
B stop-clock or timer
C total volume of the reaction mixture
D volume of sodium thiosulfate added

Your answer ☐

[1]

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2 A student investigates the reaction between sodium carbonate and dilute nitric acid.

She measures the reaction time with four different concentrations of acid.

She does all the experiments using the

- same temperature
- same mass of sodium carbonate
- same volume of acid.

Look at her results.

Concentration	Reaction time in seconds
A	41
B	74
C	135
D	67

Which concentration of nitric acid gave the **fastest** reaction?

Your answer ☐

[1]

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3 * Kayvan investigates the effect of changing the pressure and changing the temperature on this reaction.

$$\text{carbon dioxide} + \text{hydrogen} \rightleftharpoons \text{methane} + \text{water}$$

The table shows the percentage yield of methane in the equilibrium mixture under different conditions.

		Pressure in atmospheres			
		100	200	300	400
Temperature in °C	300	35%	52%	65%	80%
	600	30%	46%	58%	74%
	900	23%	37%	47%	62%
	1200	14%	25%	36%	48%

Describe what happens to the percentage yield as the pressure and temperature change and explain the effect of increasing the pressure on the rate of reaction.

[6]

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4(a) Zinc and dilute sulfuric acid react to make hydrogen.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Inga measures the rate of this reaction by measuring the **loss in mass** of the reaction mixture.

She finds that the change in mass is very small and difficult to measure.

Draw a labelled diagram to show a **better way** of measuring the rate of this reaction.

[3]

(b) The reaction between zinc and dilute sulfuric acid is slow.

Inga decides to try and find a catalyst for this reaction.

She tests four possible substances.

Each time she adds 0.5 g of the substance to 1.0 g of zinc and 25 cm^3 of dilute sulfuric acid.

Look at her table of results.

Substance	Colour of substance at start	Colour of substance at end	Relative rate of reaction
no substance			1
calcium sulfate powder	white	white	1
copper powder	pink	pink	10
copper(II) sulfate powder	blue	pink	30
manganese(IV) oxide powder	black	black	1

(i) It is important to do the reaction with **only** zinc and dilute sulfuric acid.

Explain why.

---

[1]

(ii) It is important to do all of the reactions with the same concentration of acid.

Explain why.

---

[1]

(iii) Which of the substances could be a catalyst for the reaction between zinc and dilute sulfuric acid?

Explain your answer.

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---

[2]

(iv) There is not enough evidence to confirm which substance is a catalyst.

Suggest an extra piece of experimental evidence that could be collected to confirm which substance is a catalyst.

---

[1]

(v) Inga does the experiment with copper, zinc and dilute sulfuric acid again.

This time she uses a lump of copper rather than copper powder.

Predict, with reasons, the relative rate of reaction.

---

[2]

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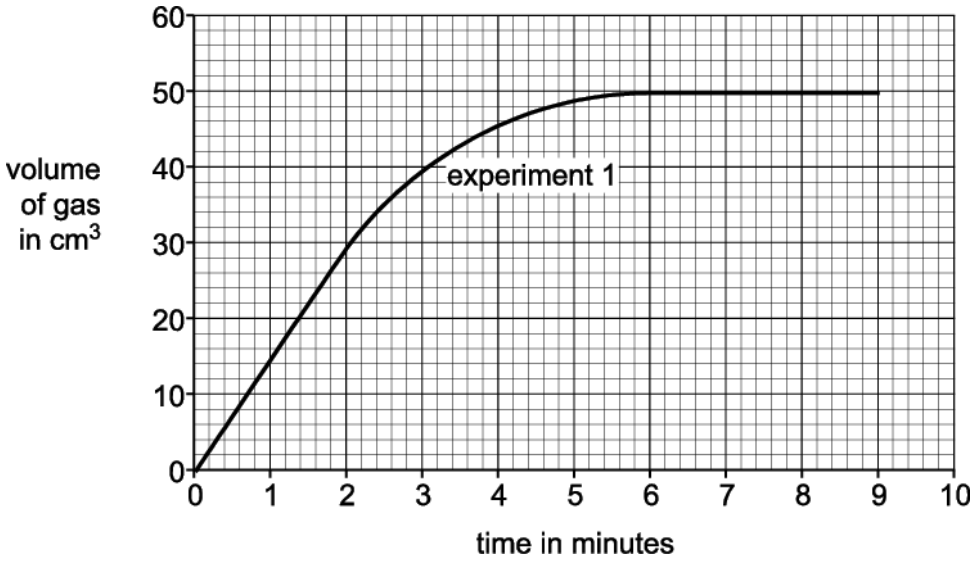
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5 A student investigates the reaction between calcium carbonate and hydrochloric acid.

He measures the volume of gas made every minute.

Look at the graph. It shows his results for the experiment.



What is the rate of reaction between 0 and 2 minutes in cm^3/minute?

A 7.5 cm^3/min
B 15 cm^3/min
C 30 cm^3/min
D 60 cm^3/min

Your answer ☐

[1]

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6 A student investigates the reaction between 1.0 g of calcium carbonate and 20 cm^3 of 1.0 mol/dm^3 hydrochloric acid at 25°C.

The student does two experiments. He uses different sized pieces of calcium carbonate for each experiment.

The rate of reaction is greater in the first experiment.

Which is the best explanation for this?

A Small pieces of calcium carbonate have a larger surface area resulting in less frequentcollisions.
B Large pieces of calcium carbonate have a larger surface area resulting in less frequentcollisions.
C Large pieces of calcium carbonate have a smaller surface area resulting in morefrequent collisions.
D Small pieces of calcium carbonate have a larger surface area resulting in morefrequent collisions.

Your answer ☐

[1]

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7(a) Zinc and dilute sulfuric acid react to make hydrogen.

$$Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$$

Inga measures the rate of this reaction by measuring the **loss in mass** of the reaction mixture.

She finds that the change in mass is very small and difficult to measure.

Draw a labelled diagram to show a **better way** of measuring the rate of this reaction.

[3]

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(b) The reaction between zinc and dilute sulfuric acid is slow.

Inga decides to try and find a catalyst for this reaction.

She tests four possible substances.

Each time she adds 0.5 g of the substance to 1.0 g of zinc and 25 cm^3 of dilute sulfuric acid.

Look at her table of results.

Substance	Colour of substance at start	Colour of substance at end	Relative rate of reaction
no substance			1
calcium sulfate powder	white	white	1
copper powder	pink	pink	10
copper(II) sulfate powder	blue	pink	30
manganese(IV) oxide powder	black	black	1

(i) It is important to do the reaction with **only** zinc and dilute sulfuric acid.

Explain why.

---

[1]

(ii) It is important to do all of the reactions with the same concentration of acid.

Explain why.

---

[1]

(iii) Which of the substances could be a catalyst for the reaction between zinc and dilute sulfuric acid?

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Explain your answer.

[2]

(iv) There is not enough evidence to confirm which substance is a catalyst.

Suggest an extra piece of experimental evidence that could be collected to confirm which substance is a catalyst.

[1]

(v) Inga does the experiment with copper, zinc and dilute sulfuric acid again.

This time she uses a lump of copper rather than copper powder.

Predict, with reasons, the relative rate of reaction.

[2]

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8 The Contact Process is used to manufacture sulfuric acid.

The Contact Process involves the reaction between sulfur dioxide and oxygen.

The conditions used are 450°C and about 10 atmospheres pressure.

(i) If the temperature is increased to 500°C the rate of reaction changes.

Describe and explain this change in rate of reaction.

--- [2]

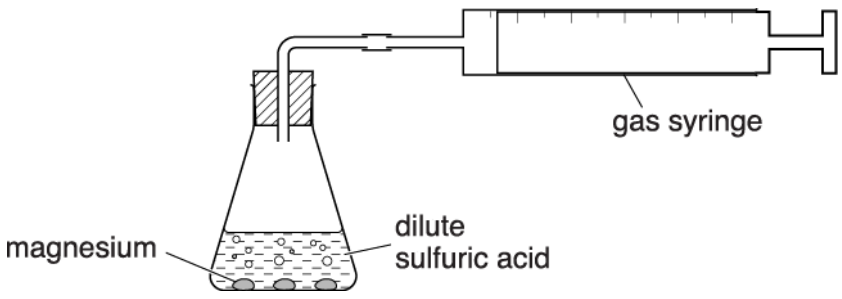
(ii) If the pressure is reduced to 5 atmospheres the rate of reaction changes.

Describe and explain this change in rate of reaction.

--- [2]

9(a) Hayley and Andy investigate the reaction between magnesium and sulfuric acid.

Look at the diagram. It shows the apparatus they use.



They add 0.1 g of magnesium to 50 cm^3 of sulfuric acid.

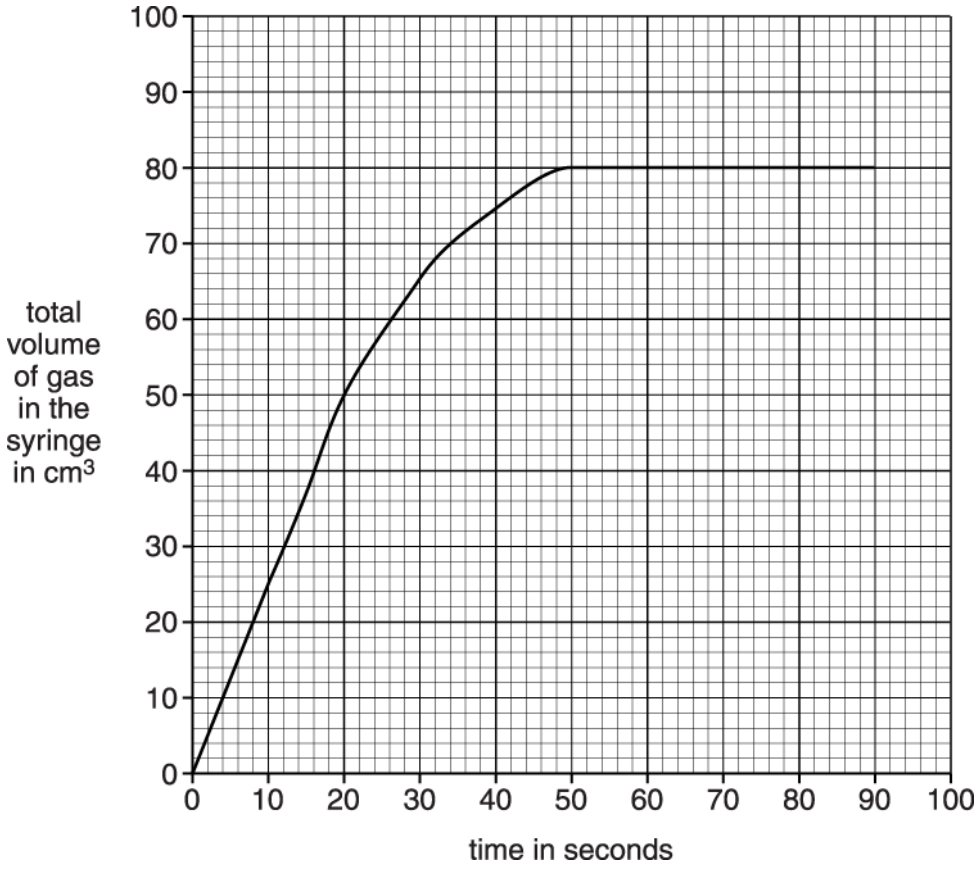
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They measure the total volume of gas in the syringe every 10 seconds.

Look at the graph of their results.



(i) What is the total volume of gas in the syringe after 20 seconds?

answer _____ cm^3

[1]

(ii) How long does it take for the reaction to stop?

answer _____ seconds

[1]

(b) Explain why the reaction stops.

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[1]

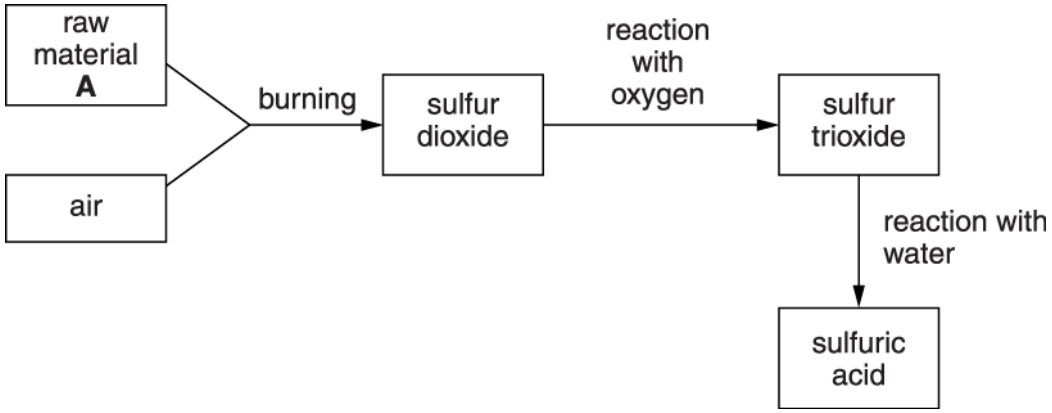
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10 This question is about the Contact Process used for the manufacture of sulfuric acid.

Look at the flow chart for the process.



Look at the table.

It shows how the percentage yield of sulfur trioxide changes as the temperature changes.

Temperature in °C	Percentage (%) yield of sulfur trioxide
200	98
400	90
600	47
800	18
1000	5

(i) How does **decreasing** the temperature affect the percentage yield?

_____ [1]

(ii) Estimate the percentage yield of sulfur trioxide at 700 °C.

answer _____ %

[1]

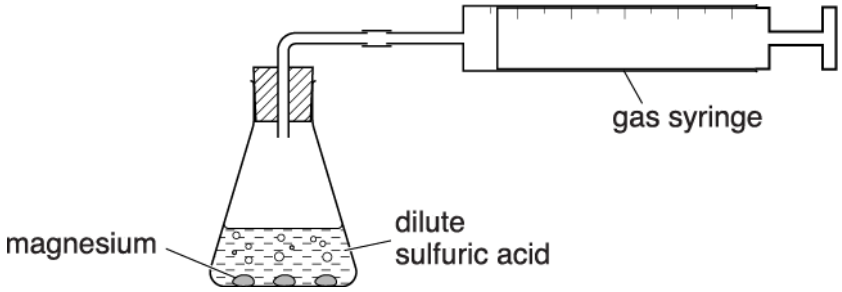
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11 Hayley and Andy investigate the reaction between magnesium and sulfuric acid.

Look at the diagram. It shows the apparatus they use.

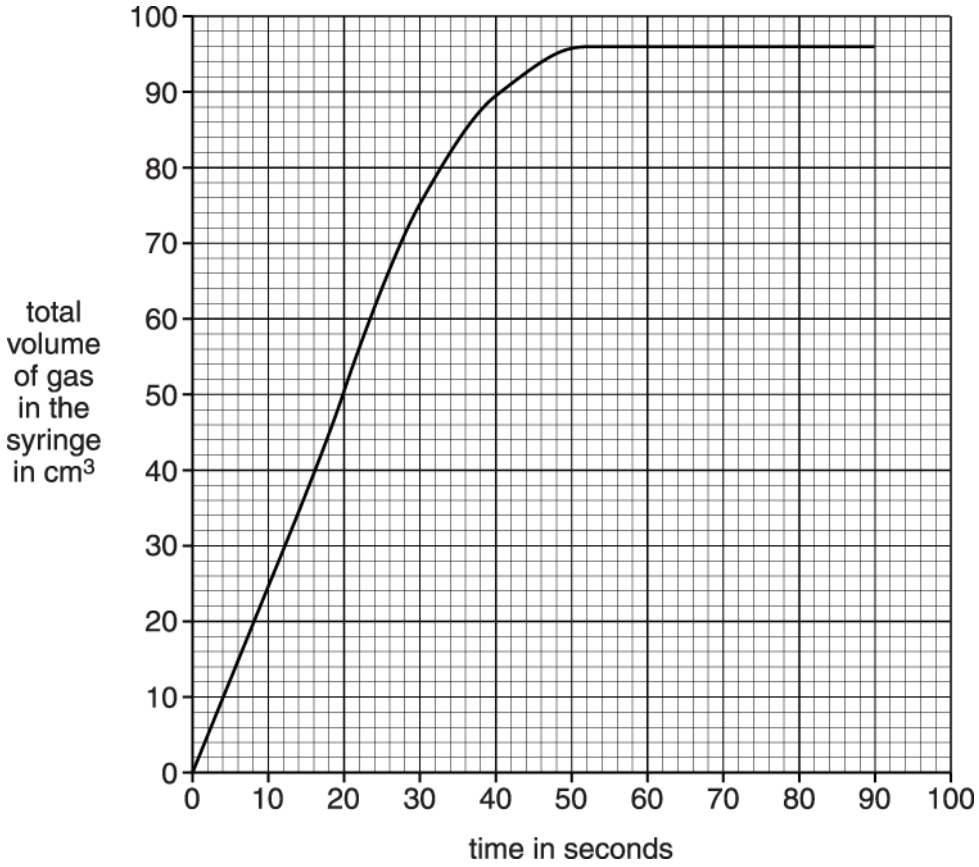


They add 0.1 g of magnesium to 50 cm^3 of sulfuric acid.

They measure the total volume of gas in the syringe every 10 seconds.

All the magnesium is used up at the end of the reaction.

Look at the graph of their results.



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(i) What is the total volume of gas in the syringe after 30 seconds?

answer _____ cm^3 [1]

(ii) How long does it take for the reaction to stop?

answer _____ seconds [1]

(iii) Hayley and Andy do the experiment again.

They use the same volume and concentration of sulfuric acid.

This time they only use 0.05 g of magnesium.

On the grid, sketch the graph they should get. [2]

12 Look at the equation for the reaction.

magnesium + sulfuric acid → magnesium sulfate + hydrogen

Hayley and Andy investigate this reaction with different masses of magnesium.

They calculate the mass of sulfuric acid used and the masses of magnesium sulfate and hydrogen made.

Mass of magnesium in g	Mass of sulfuric acid in g	Mass of magnesium sulfate in g	Mass of hydrogen in g
0.50	2.04	2.50	0.04
1.00	4.08	5.00	0.08
1.50	6.12	7.50	0.12
2.00	8.16	10.00	0.16

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(i) Calculate the mass of magnesium sulfate made if 10 g of magnesium completely reacts with sulfuric acid.

Explain how you worked out your answer.

---

[2]

(ii) A sample of 2.00 g of magnesium makes 0.16 g of hydrogen.

Calculate the number of moles in 0.16 g of hydrogen, H2.

The relative atomic mass, Ar, of H = 1.

number of moles = _____

[1]

(iii) Calculate the volume of 0.16 g of hydrogen at room temperature and pressure.

1 mole of hydrogen occupies 24 000 cm3 at room temperature and pressure.

volume = _____ cm^3

[1]

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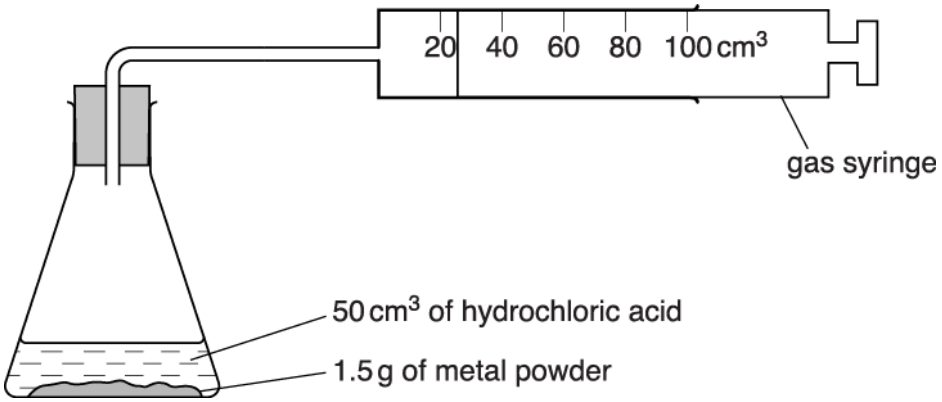
13 Zinc reacts with hydrochloric acid.

Hydrogen gas and zinc chloride are made.

Fatimah and Sam investigate the reaction between acid and metals.

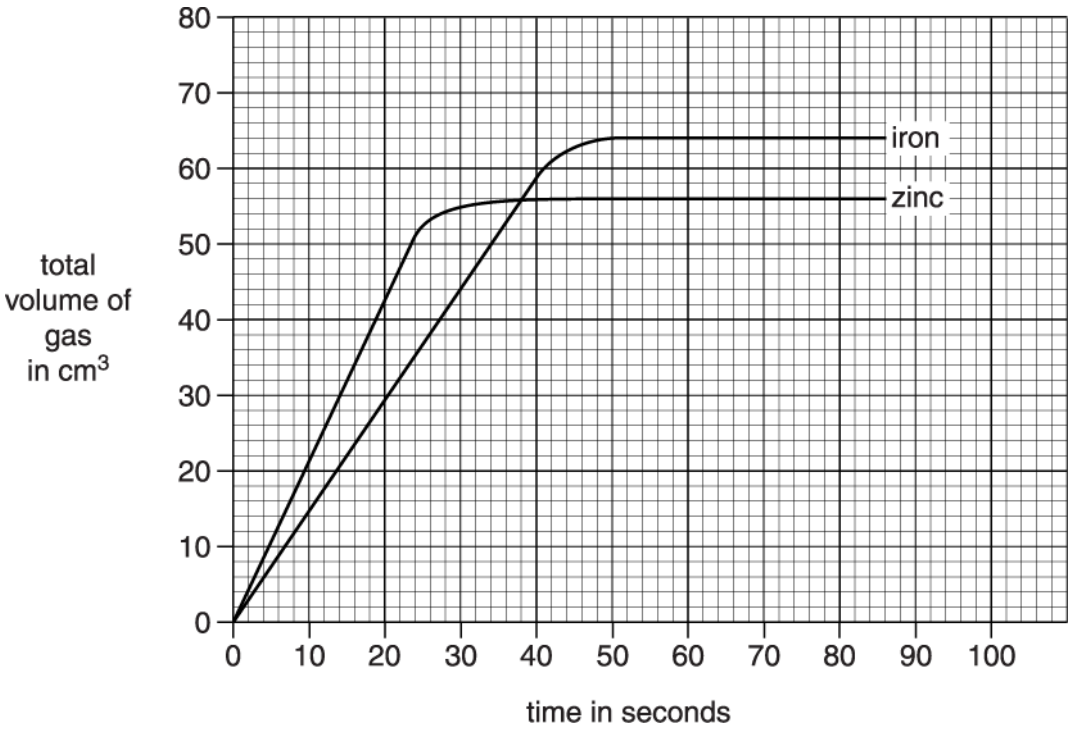
They react dilute hydrochloric acid with zinc powder and then with iron powder.

Look at the apparatus they use.



Every 10 seconds they measure the volume of gas in the gas syringe.

Look at the graph of the results.



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(i) The graph for the reaction of **zinc** is different from the graph for **iron**.

Write about **two** differences in these graphs.

--- [2]

(ii) Iron powder reacts faster than a lump of iron of the same mass.

Explain why.

--- [1]

(iii) Fatimah and Sam want to make the reaction between iron powder and dilute hydrochloric acid **faster**.

They do not want to change the mass of the iron powder or the volume of acid.

Write about **three** ways they can make the reaction faster.

--- [3]

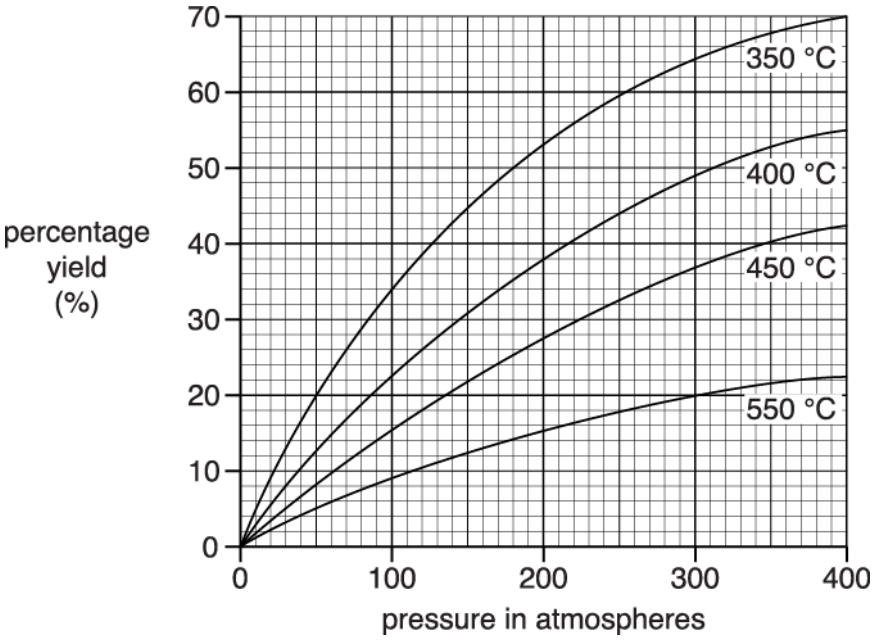
14 This question is about making ammonia by the Haber process.

Nitrogen and hydrogen react to make ammonia.

Look at the graph.

It shows the yield of ammonia under different conditions of temperature and pressure.

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One cost of making ammonia is the **energy** needed.

Write about some of the **other** costs of making ammonia.

Use the graph to decide the conditions that give the **highest** yield of ammonia.

The quality of written communication will be assessed in your answer to this question.

[6]

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15(a) Zinc, Zn, reacts with hydrochloric acid, HC*l* .

Hydrogen gas, H_2, and zinc chloride, $ZnCl_2$, are made.

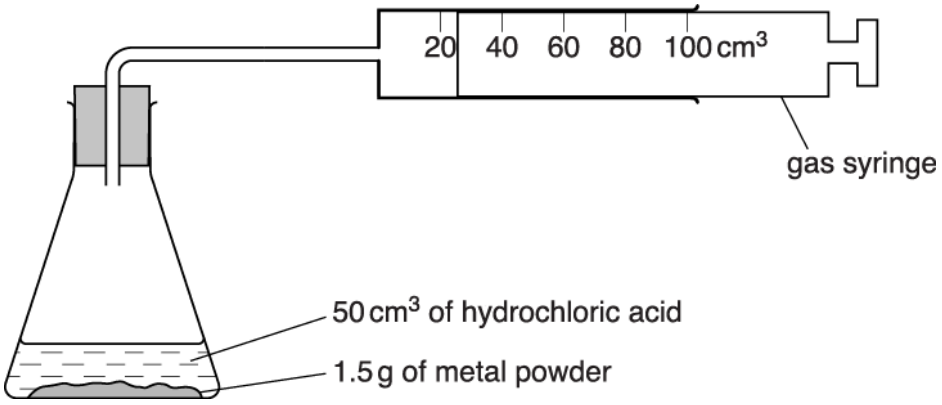
Construct the **balanced symbol** equation for this reaction.

[1]

(b) Fatimah and Sam investigate the reaction between acid and metals.

They react dilute hydrochloric acid with zinc powder and with iron powder.

Look at the apparatus they use.



Every 10 seconds they measure the volume of gas in the gas syringe.

Fatimah and Sam do three different experiments.

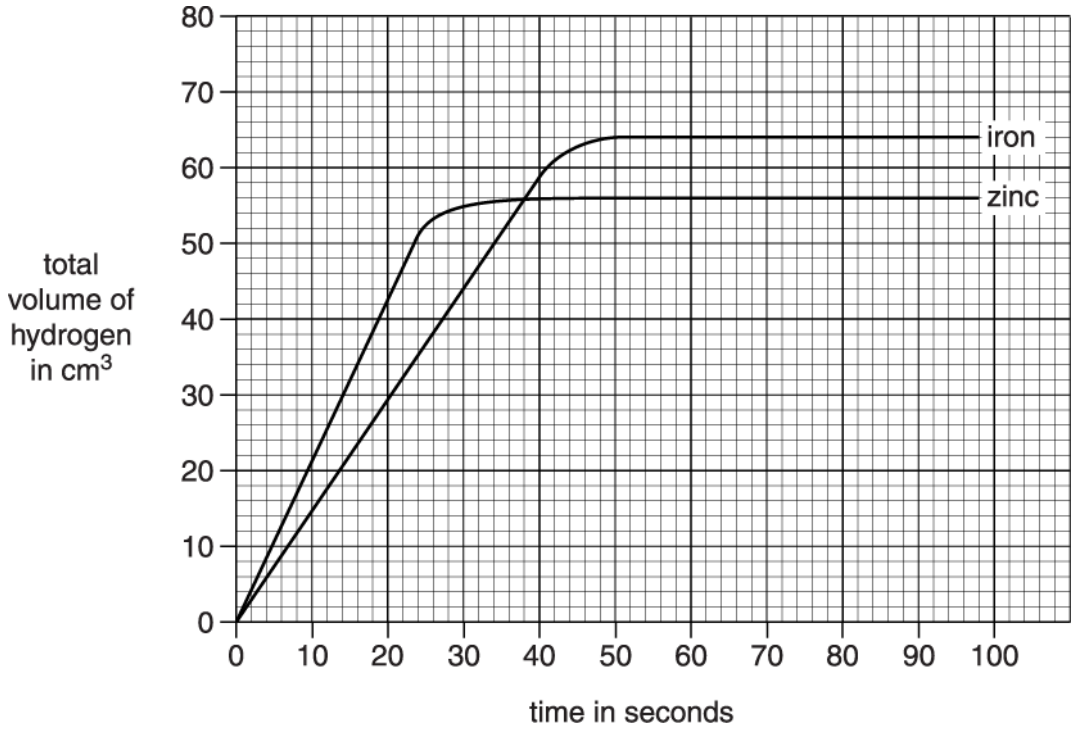
- 50 cm^3 hydrochloric acid and 0.15 g of zinc
- 50 cm^3 hydrochloric acid and 0.15 g of iron
- 50 cm^3 hydrochloric acid and 0.075 g of iron mixed with 0.075 g of zinc.

Look at the graph of the results for the first two experiments.

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(i) Calculate the rate of reaction of **iron** during the **first 30 seconds**.

---

rate of reaction = _____ cm^3 / s

[1]

(ii) Predict the total volume of hydrogen formed when the **mixture** of zinc and iron powder is used.

_____ cm^3

[1]

(c) Increasing the concentration of a reactant in solution will increase the rate of reaction.

Use the reacting particle model to explain why.

---

[2]

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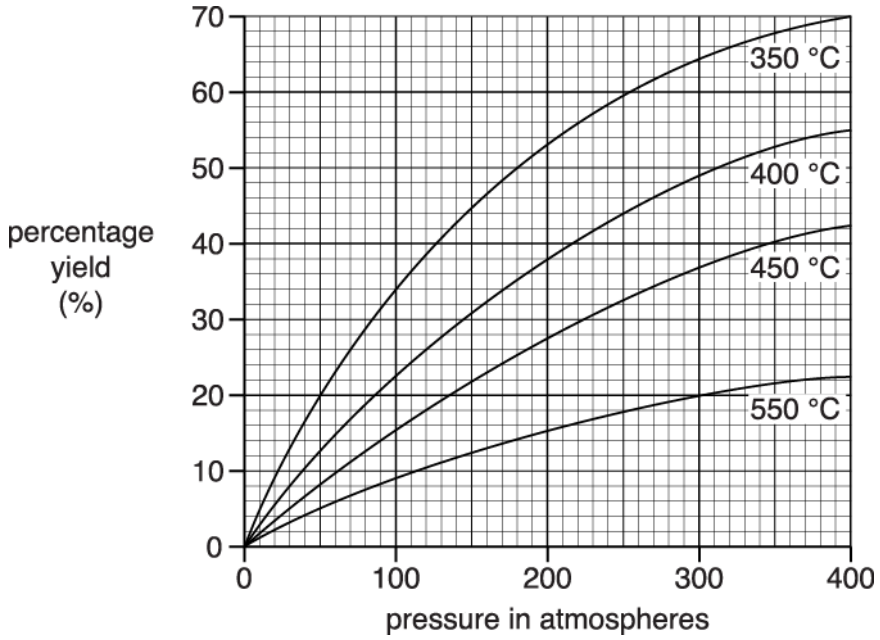
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16 This question is about the conditions used in the Haber process to make ammonia.

Look at the graph.

It shows the yield of ammonia under different conditions of temperature and pressure.



In the manufacture of ammonia, the conditions used are:

- a pressure of 200 atmospheres
- a temperature of 450 °C.

Use the graph to decide the conditions of temperature and pressure that give the **highest** yield of ammonia.

Explain why the conditions that give the highest yield are **not** used in the Haber process.

The quality of written communication will be assessed in your answer to this question.

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[6]

17 Nitrogen molecules react with oxygen molecules.

Nitrogen monoxide molecules are made.

$$N_2 + O_2 \text{ ? } 2NO$$

The reaction is endothermic.

Nitrogen molecules and oxygen molecules react extremely slowly, even at 200 °C.

The reaction between nitrogen and oxygen becomes faster as both the temperature and the pressure increase.

Explain why, using the reacting particle model.

The quality of written communication will be assessed in your answer to this question.

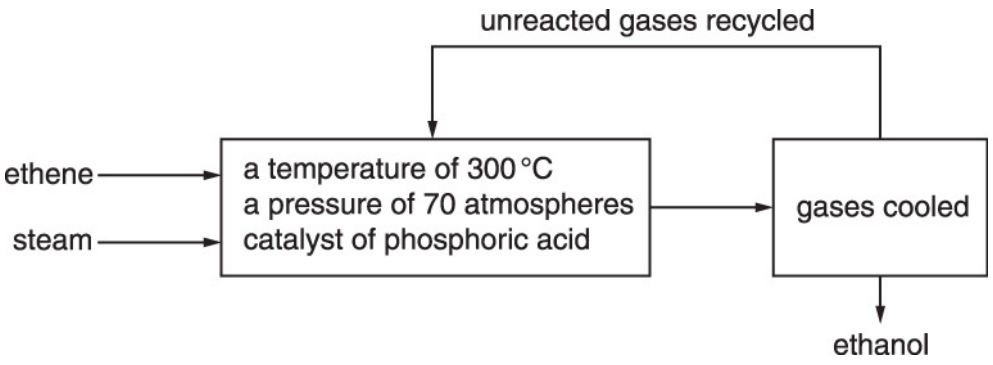
[6]

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18(a) Ethanol (alcohol) is made by reacting ethene with steam.

$$\text{ethene} + \text{steam} \rightleftharpoons \text{ethanol}$$

Look at the flowchart.



Look at the table.

It gives some information about the percentage yield of ethanol at different temperatures and pressures.

Pressure in atmospheres	Percentage yield		
	200 °C	300 °C	400 °C
40	16	12	6
80	30	22	12
120	42	30	17
160	50	36	21

(i) What happens to the percentage yield as the **pressure** increases?

---

[1]

(ii) What happens to the percentage yield as the **temperature** increases?

---

[1]

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(b) The highest percentage yield is achieved with a temperature of 200 °C and 160 atmospheres.

The actual conditions used to make ethanol are:

- catalyst of phosphoric(V) acid
- a pressure of 70 atmospheres
- a temperature of 300 °C.

Use ideas about percentage yield and rate of reaction to suggest why each condition is used.

---

[3]

(c) This process is automated.

Explain why automation is used.

---

[1]

19 Nitrogen molecules and oxygen molecules react extremely slowly, even at 200 °C.

Write about the **different ways** in which the reaction between nitrogen and oxygen can be made faster and explain, using the reacting particle model, how one of these ways works.

The quality of written communication will be assessed in your answer to this question.

---

[6]

20(a) Mark is washing his clothes.

Look at the contents of Mark's washing powder.

active detergent
water softener
bleach
optical brightener
enzymes

The **enzyme** is needed in low temperature washes.

What is the job of the enzyme?

---

[1]

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(b) What are the advantages of using **low temperature** washes?

---

[2]

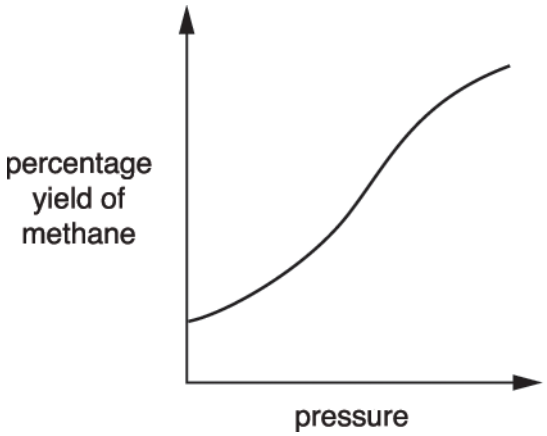
21 Methane is a fuel that can be made by the reaction between carbon dioxide and hydrogen.

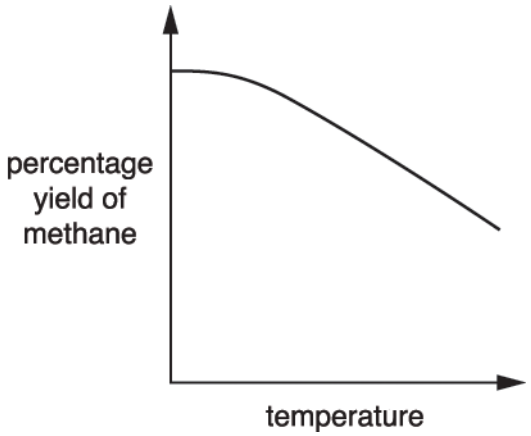
$$CO_2(g) + 4H_2(g) \text{ ? } CH_4(g) + 2H_2O(g)$$

Paul predicts that

- the percentage yield of methane increases when the temperature increases
- the percentage yield of methane increases when the pressure increases.

Look at the two graphs.





Do the graphs support Paul's predictions?

Explain your answer.

---

[2]

22 This question is about acids.

Nitric acid is a strong acid and propanoic acid is a weak acid.

David investigates the reaction of both of these acids with calcium carbonate.

David does two experiments

- the first with nitric acid
- the second with propanoic acid.

Each time he puts 50 cm^3 of 1.0 mol/dm^3 acid into a conical flask.

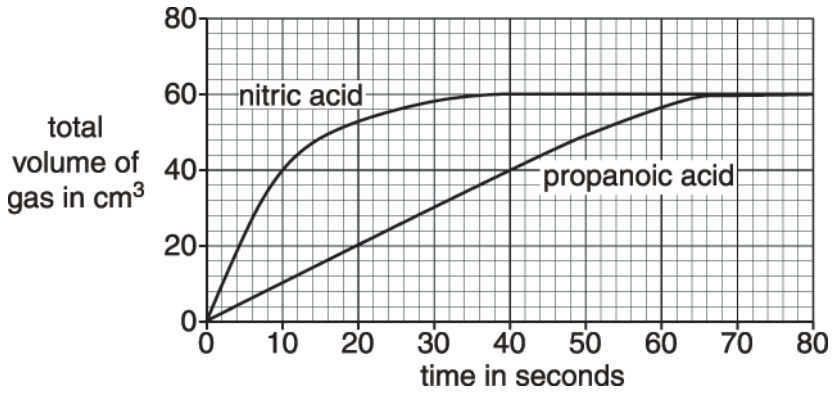
He then adds 0.25 g of calcium carbonate to the acid.

David measures the total volume of gas made every 10 seconds.

(i) Draw a **labelled** diagram of the apparatus David can use in these experiments.

[2]

(ii) Look at the graph of David's results.



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Explain why the two lines are different but the final volume of gas at the end of the reaction is the same.



The quality of written communication will be assessed in your answer to this question.

[6]

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23 Faye is a scientist. She works for Didcot Detergents.

Faye is researching some new detergents.

Look at the table. It shows if her new detergents remove different stains at low temperatures.

Detergent	Is stain removed?			
	Food	Paint	Grease	Blood
A	✗	✓	✗	✗
B	✗	✓	partly	✗
C	✓	✗	✓	✓
D	✗	✗	✓	✗

One of the detergents contains an **enzyme.**

Suggest which one.

_____

Explain your answer.

_____

_____

_____ [2]

24 Ethanol can be made by the fermentation of glucose.

Tina and Tommy investigate the fermentation of glucose.

They use 50 cm^3 of glucose solution and 1 g of yeast.

Tina and Tommy measure the volume of carbon dioxide made after 10 minutes.

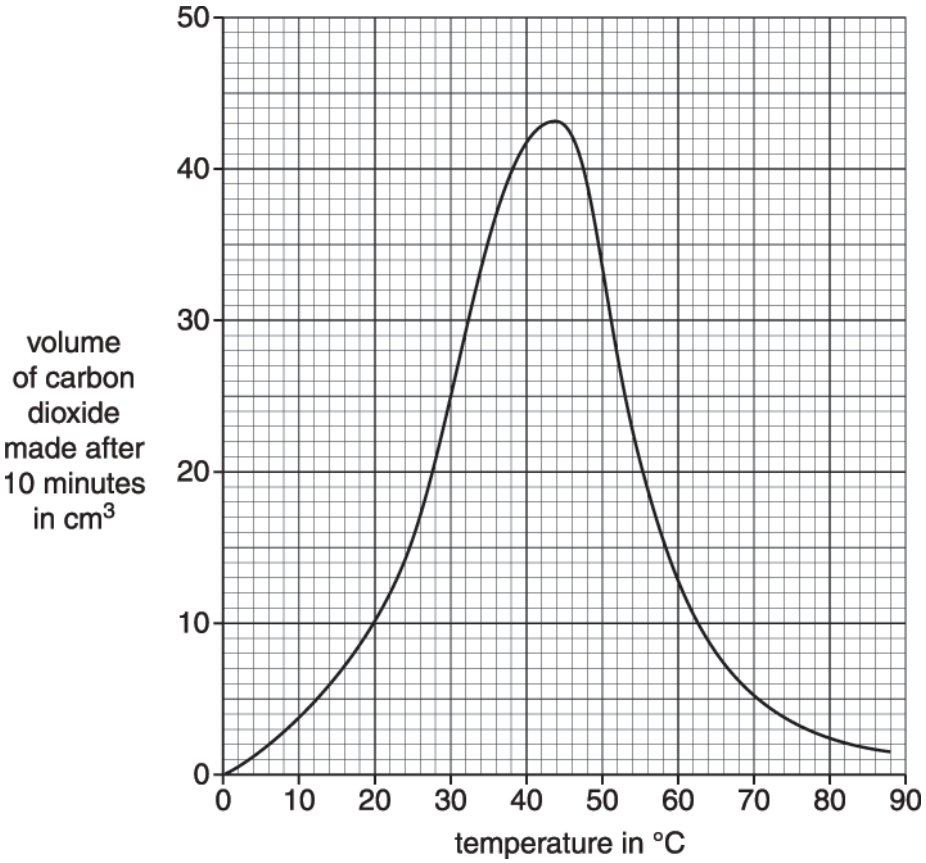
They do the experiment at different temperatures.

Look at the graph. It shows their results.

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(i) What is the volume of carbon dioxide made at 60 °C?

answer _____ cm^3

[1]

(ii) At what temperature is the reaction fastest?

answer _____ °C

Explain your answer.

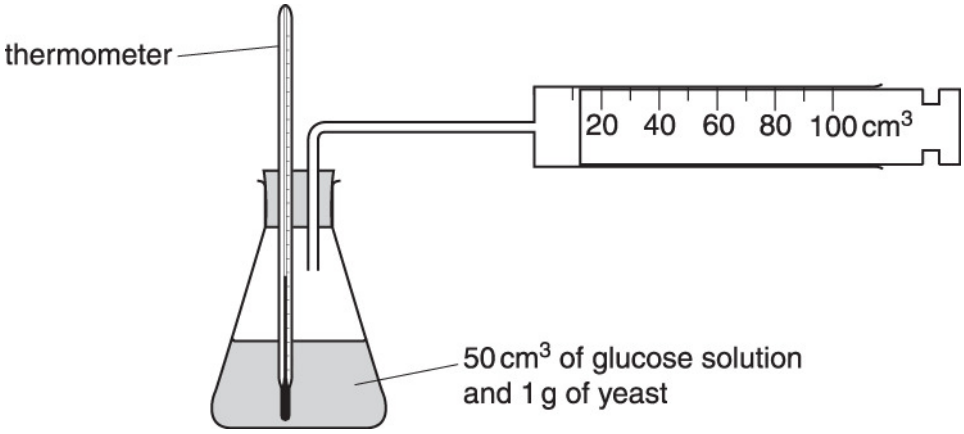
_____

_____ [2]

25 Ethanol can be made by the fermentation of glucose.

Tina and Tommy investigate the fermentation of glucose.

Look at the diagram. It shows the apparatus they use.



Tina and Tommy measure the volume of carbon dioxide made after 10 minutes.

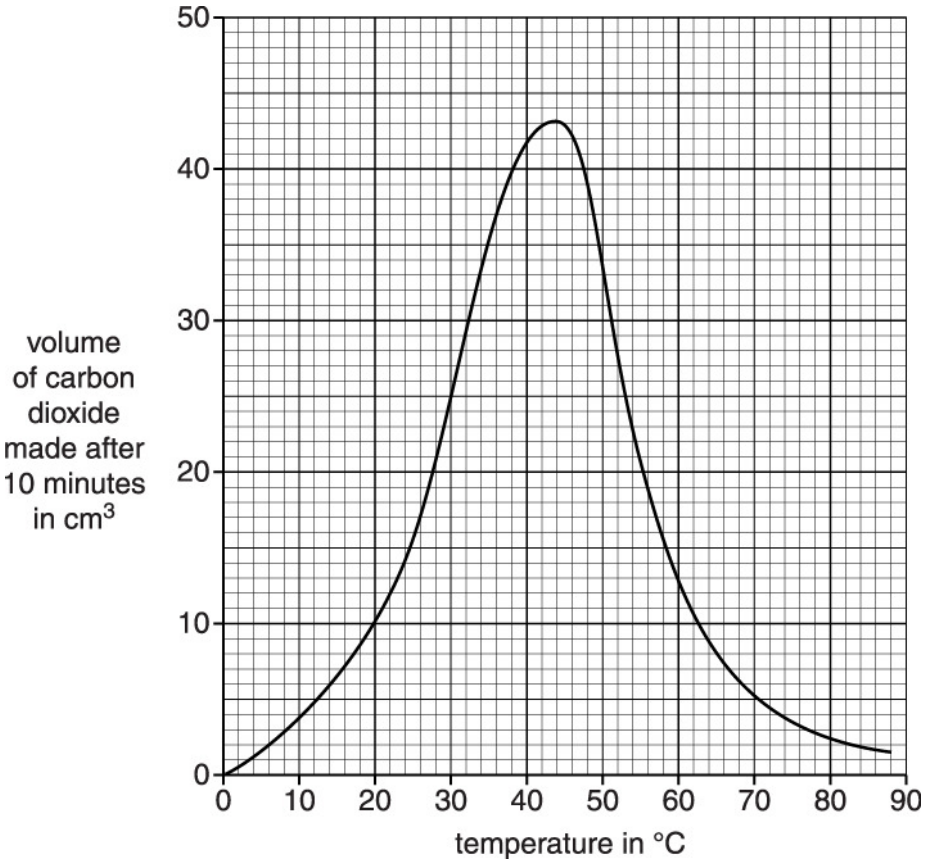
They do the experiment at different temperatures.

Look at the graph. It shows their results.

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(i) What is the volume of carbon dioxide made at **70 °C**?

answer _____ cm^3

[1]

(ii) At what temperature is the reaction fastest?

answer _____ °C

Explain your answer.

---

[2]

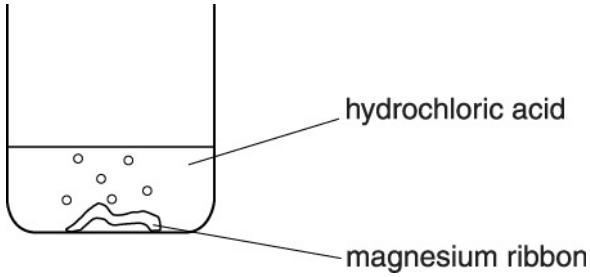
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26(a) Rachel investigates the reaction between magnesium and hydrochloric acid.

She adds a piece of magnesium ribbon to hydrochloric acid in a beaker.

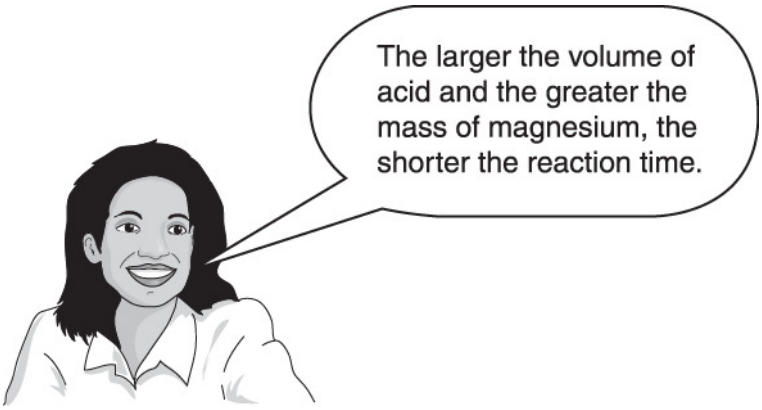


Rachel measures the time it takes for all the magnesium ribbon to react.

This is the reaction time.

She does five different experiments.

Look at Rachel's prediction.



Look at Rachel's results.

Experiment number	Mass of magnesium used in g	Volume of acid used in cm^3	Concentration of acid in mol/dm^3	Reaction time in seconds
1	0.05	25	1.0	30
2	0.10	25	1.0	30
3	0.05	50	1.0	30
4	0.05	50	2.0	15
5	0.10	50	2.0	15

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Explain if Rachel's results support her prediction. Use the reacting particle model to explain the difference between the reaction time in experiments **3** and **4**.

The quality of written communication will be assessed in your answer to this question.

[6]

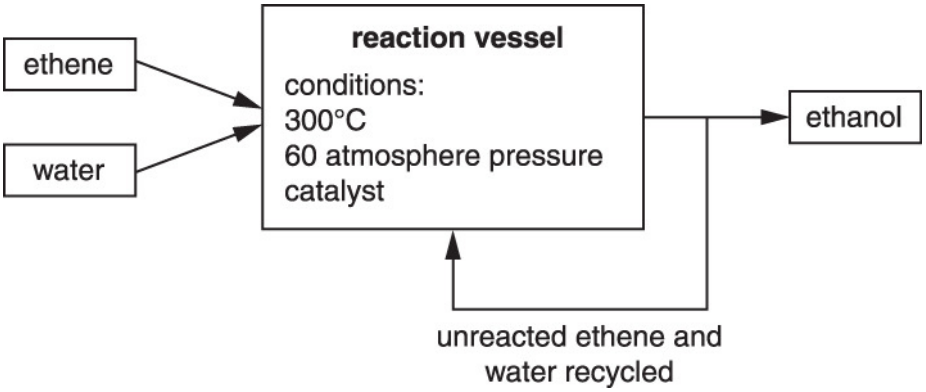
(b) Rachel repeats experiment **1**. This time she uses acid at a **higher** temperature.

Explain, using the reacting particle model, what happens to the rate of reaction.

[2]

27(a) Ethanol can be made from ethene and water.

The flowchart shows this process.



The symbol equation for the reaction is:

$$C_2H_4 + H_2O \rightleftharpoons C_2H_6O$$

The percentage of ethanol changes as the temperature and pressure change.

Look at the table.

It shows the percentage of ethanol at different temperatures and pressures.

Pressure in atmospheres	Percentage of ethanol (%)			
	At 100°C	At 200°C	At 300°C	At 400°C
20	15	10	5	2
40	20	15	10	5
60	40	30	20	10
80	60	50	40	20

Which of the following conditions gives the **highest** percentage of ethanol?

1 high pressure with high temperature
2 high pressure with low temperature
3 low pressure with high temperature
4 low pressure with low temperature

Choose from **A**, **B**, **C** or **D**.

answer _____

[1]

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(b) The conditions used for making **ethanol** are:

- 300°C
- 60 atmospheres pressure.

Suggest why these conditions are used even though the percentage of ethanol is only 20%.

---

[2]

28(a) Fatimah investigates the reaction between sodium hydrogencarbonate and dilute hydrochloric acid.

Fatimah does two investigations.

She always adds 0.5 g of sodium hydrogencarbonate to 20 cm^3 of dilute hydrochloric acid.

She measures the time it takes for the reaction mixture to stop bubbling.

This is called the **reaction time**.

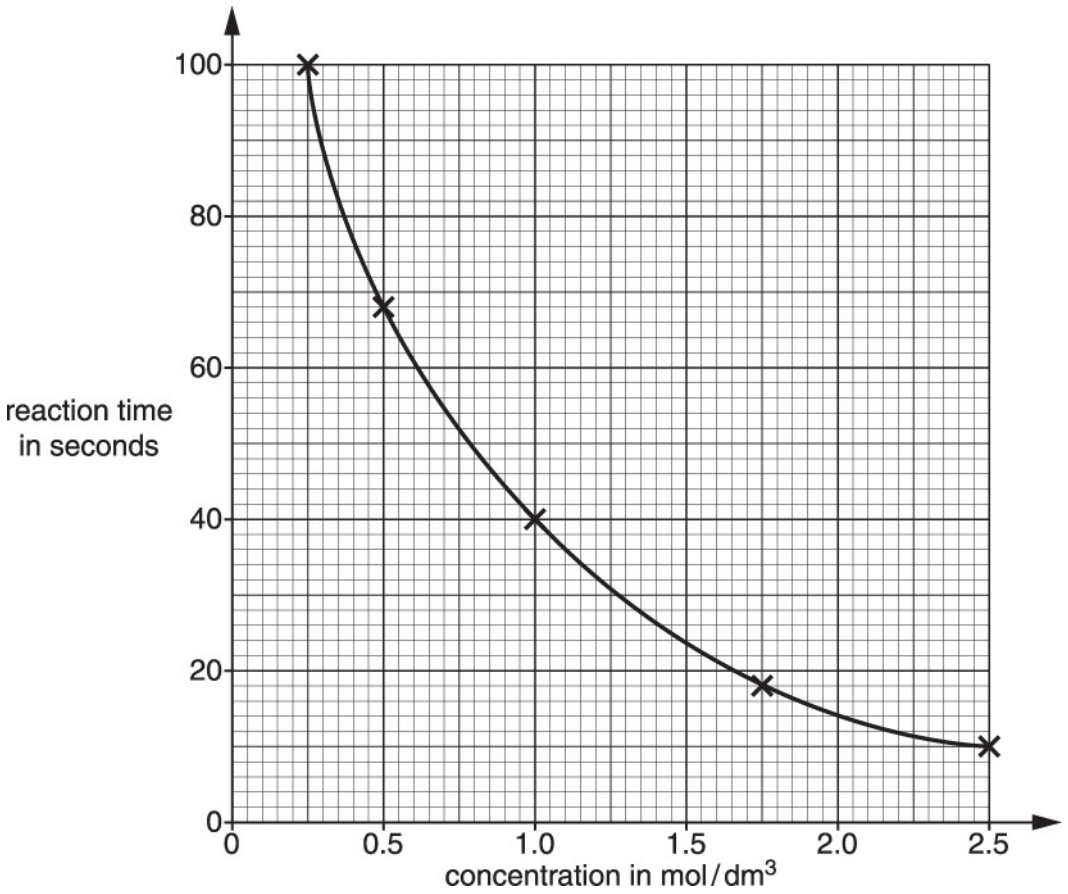
Investigation One

She does five different experiments.

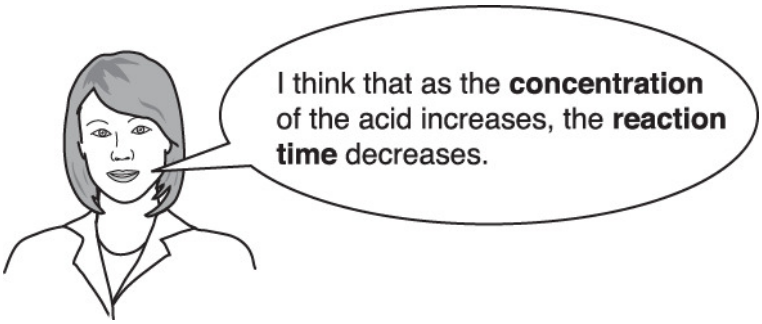
She keeps the temperature the same.

Each experiment uses a **different concentration** of acid.

Look at a graph of her results.



Fatimah makes a conclusion.



Do the results in **Investigation one** support Fatimah's conclusion?

Explain your answer.

Use the reacting particle model to explain Fatimah's results.

The quality of written communication will be assessed in your answer to this question.

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[6]

(b) **Investigation Two**

Fatimah does five experiments.

She keeps the concentration of the acid the same.

She uses acid at **different temperatures**.

Look at her results.

Temperature of acid in °C	Reaction time in seconds
20	68
30	34
40	17
50	9
60	5

(i) What conclusion can you make about the effect of **temperature** on the **reaction time**?

---

[1]

(ii) Fatimah does an experiment with acid at a temperature of 10°C.

Predict the reaction time, in seconds.

_____ seconds

[1]

29(a) Hilary investigates the reaction between magnesium and hydrochloric acid.

Magnesium chloride and hydrogen are made.

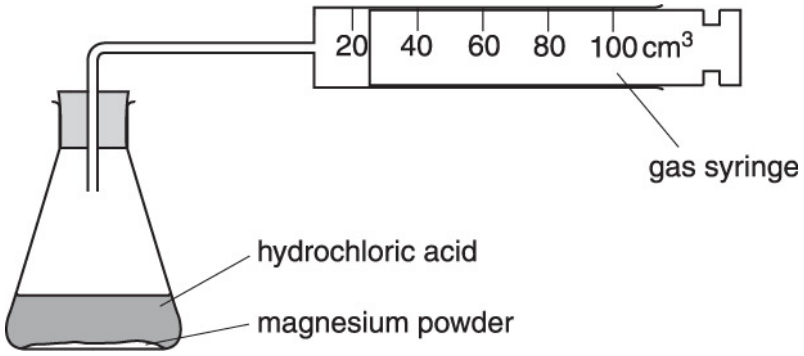
Look at the diagram.

It shows the apparatus she uses.

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Hilary measures the total volume of gas in the syringe every 10 seconds.

Look at Hilary's results.

Time in seconds	Total volume of gas in syringe in cm^3
0	0
10	20
20	35
30	45
40	49
50	50
60	50

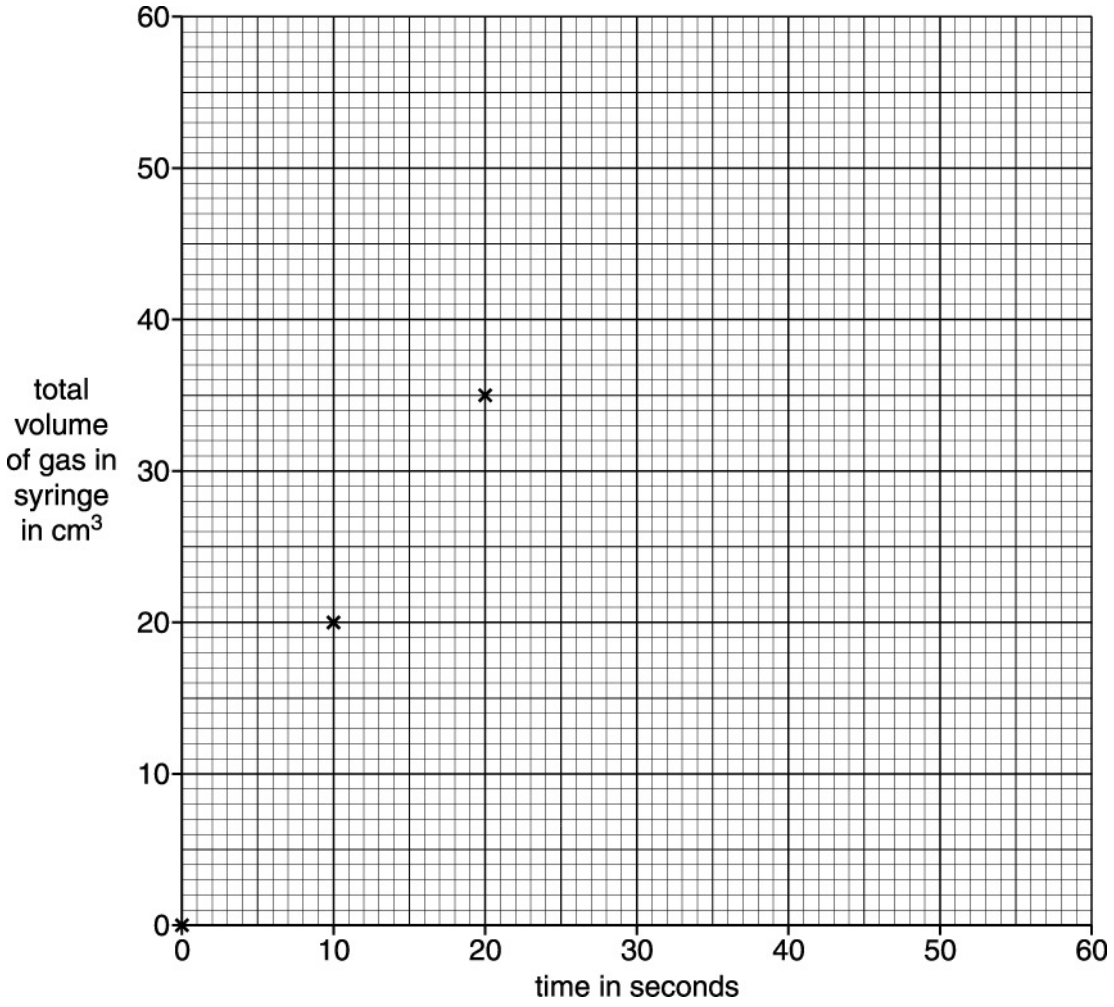
(i) **Plot** these results on the graph and draw the best line through the points.

The first three points have been plotted for you.

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[2]

(ii) Look at the results.

The reaction stops after **50 seconds**. No more gas is given off.

Explain why.

---

[1]

(b) Hilary repeats the experiment.

This time she uses **lumps** of magnesium.

The reaction is **slower**.

Explain, using the reacting particle model, why the reaction is slower.

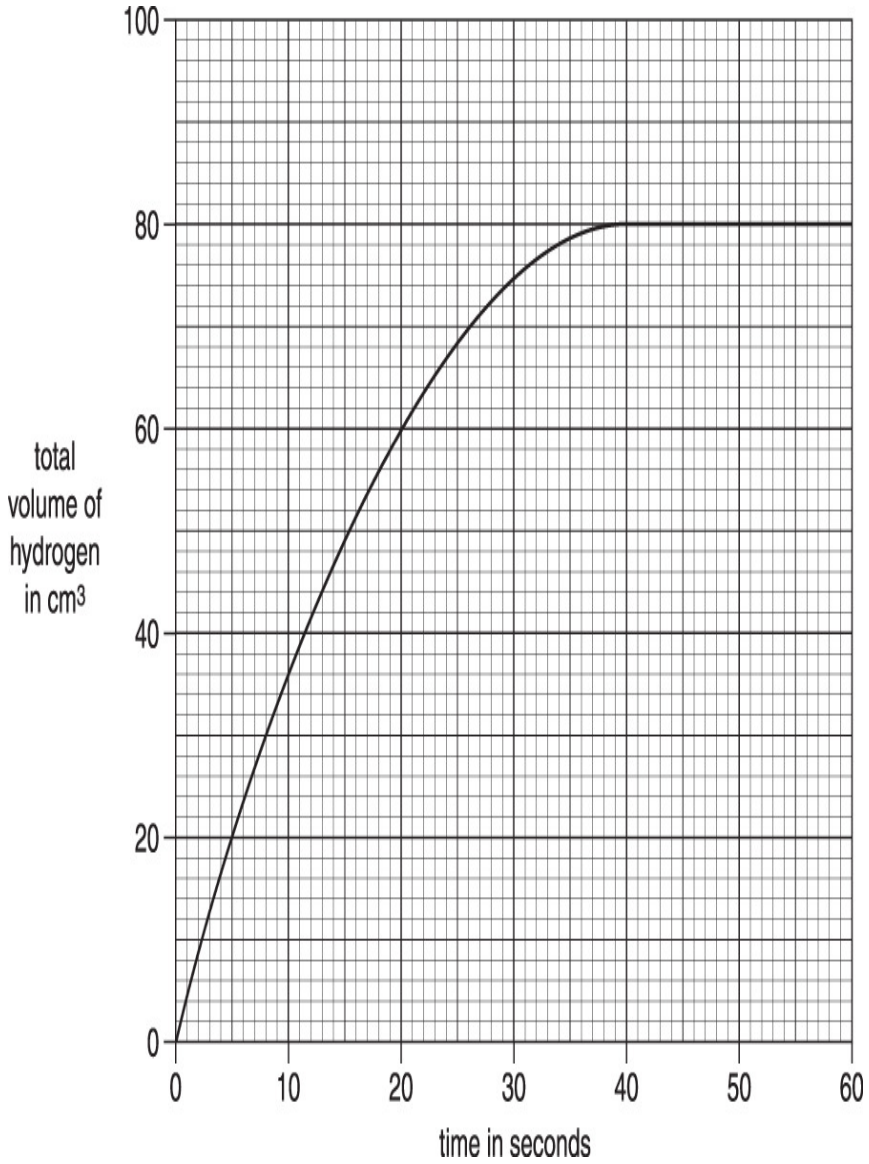
---

[2]

30 Trevor and Julie investigate the reaction between magnesium and hydrochloric acid at 20 °C.

magnesium + hydrochloric acid ? magnesium chloride + hydrogen

Look at the graph. It shows their results.



(i) How long does it take for the reaction to stop?

answer _____ seconds

[1]

(ii) Why does the reaction stop?

[1]

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31 Fatimah investigates the reaction between sodium hydrogencarbonate and dilute hydrochloric acid.

She always adds 0.5 g of sodium hydrogencarbonate to 20 cm^3 of dilute hydrochloric acid.

She measures the time it takes for the reaction mixture to stop bubbling.

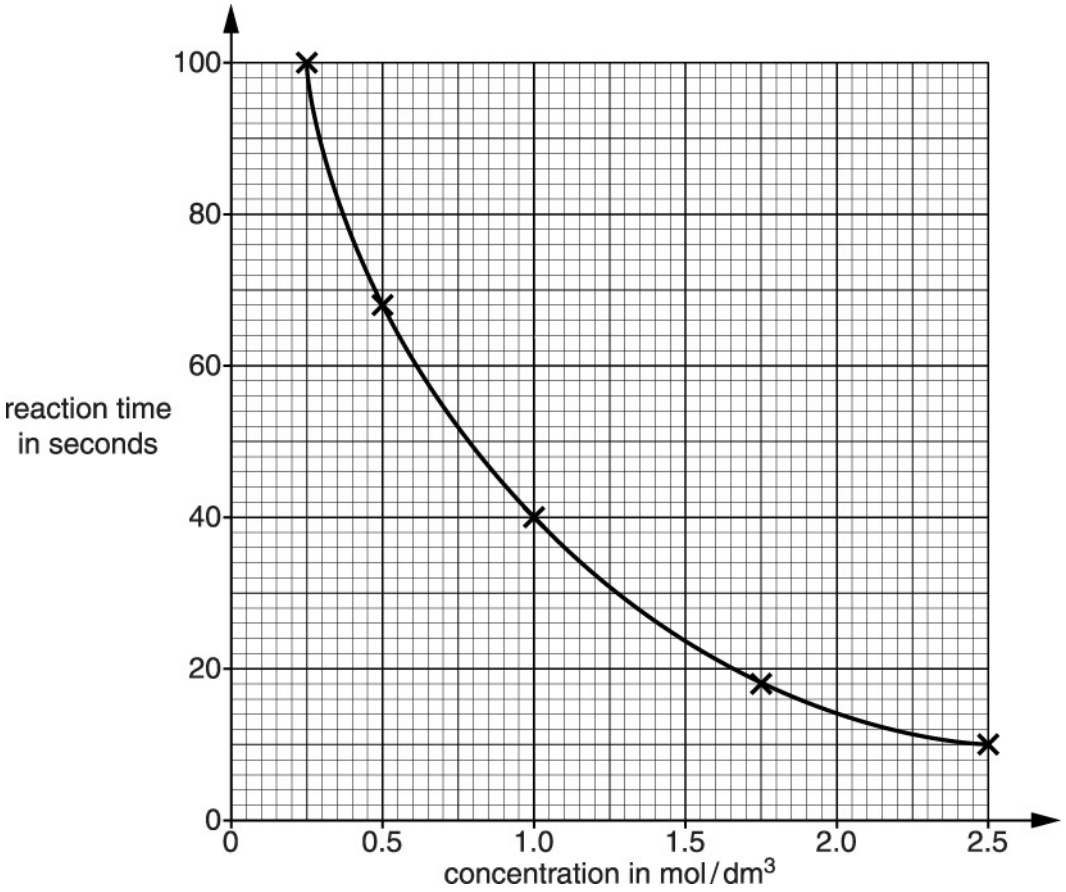
This is called the **reaction time**.

She does five different experiments.

She keeps the temperature the same.

Each experiment uses a **different concentration** of acid.

Look at a graph of her results.



Fatimah concludes that as the concentration of acid increases, the rate of reaction increases.

Explain, with a reason, whether the results support Fatimah's conclusion.

Use the reacting particle model to explain Fatimah's results.

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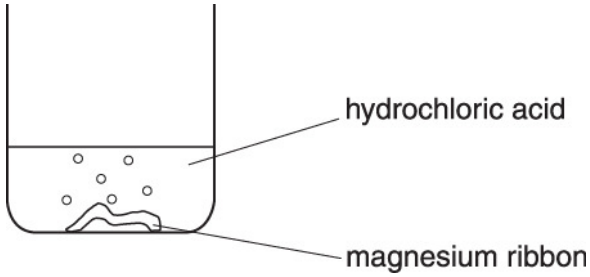
The quality of written communication will be assessed in your answer to this question.

[6]

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32(a) Rachel investigates the reaction between magnesium and hydrochloric acid.

She adds a piece of magnesium ribbon to hydrochloric acid in a beaker.

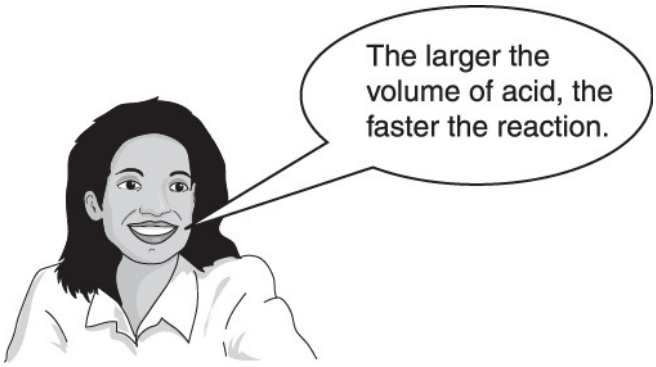


Rachel measures the time it takes for all the magnesium ribbon to react.

This is the reaction time.

She does four different experiments.

Look at Rachel's prediction.



Look at Rachel's results.

Experiment number	Mass of magnesium used in g	Volume of acid used in cm^3	Concentration of acid in mol/dm^3	Reaction time in seconds
1	0.05	25	1.0	30
2	0.10	25	1.0	30
3	0.05	50	1.0	30
4	0.05	50	2.0	15

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Explain if Rachel's results support her prediction. Use the reacting particle model to explain the difference between the reaction time in experiments **3** and **4**.

The quality of written communication will be assessed in your answer to this question.

---

[6]

(b) Rachel repeats experiment **1**. This time she uses acid at a **higher** temperature.

Predict, with a reason, the reaction time for this new experiment.

Predicted reaction time: _____ seconds

Reason _____

---

[2]

33 The rate of a reaction can be changed by adding a catalyst to the reaction mixture.

Which line of the table shows how the **rate of reaction** and the **mass of the catalyst** change as the reaction takes place?

	Change in rate of reaction	Change in mass of catalyst
A	decreases	no change
B	no change	decreases
C	increases	no change
D	increases	decreases

Your answer [ ] **[1]**

34 Nanoparticles are being used to make a material that is better than Kevlar® at resisting bullets.

Nanoparticles are often made of silicon dioxide.

A silicon dioxide nanoparticle has a diameter of 18 nm.

The diameter of a silicon atom is 0.22 nm.

(i) Estimate how many times larger the silicon dioxide nanoparticle is, compared to a silicon atom.

Give your answer to **1** significant figure.

Number of times larger = ... **[3]**

(ii) Silicon dioxide is used as a **catalyst**.

Suggest why 1 g of silicon dioxide is **more effective** as a catalyst when used as nanoparticles rather than as a powder.

---

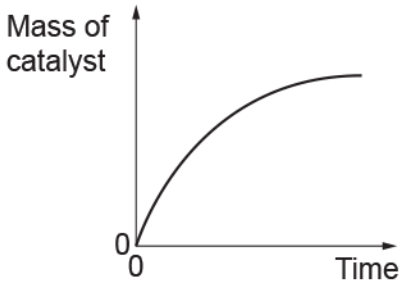
[3]

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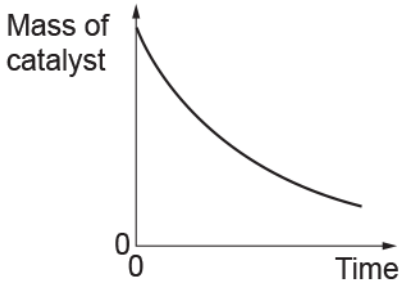
35 A catalyst can be used to increase the rate of a reaction.

Which graph shows the **mass of the catalyst** as the reaction takes place?

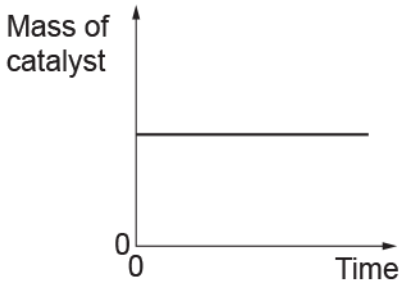
A



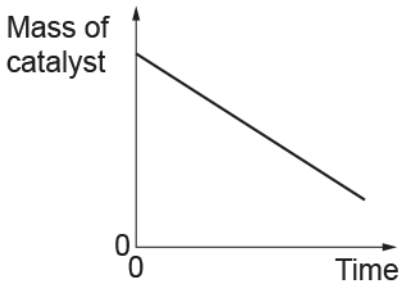
B



C



D



Your answer [ ] [1]

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36(a) *The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

"The smaller the volume of acid and the greater the concentration of acid, the faster the reaction rate."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm^3)	Concentration of acid (mol / dm^3)	Reaction time (s)
1	0.05	25	1.0	30
2	0.05	50	1.0	30
3	0.05	50	2.0	15
4	0.10	25	1.0	30
5	0.10	50	2.0	15

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

[6]

(b) The student repeats experiment **1**. This time he uses acid at a **higher** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

[3]

37 Nanoparticles are being used to make a material that is better than Kevlar® at resisting bullets.

Nanoparticles are often made of silicon dioxide.

A silicon dioxide nanoparticle has a diameter of 18 nm.

The diameter of a silicon atom is 0.22 nm.

(i) Estimate how many times larger the silicon dioxide nanoparticle is, compared to a silicon atom.

Give your answer to **1** significant figure.

Number of times larger = ... **[3]**

(ii) Silicon dioxide is used as a **catalyst**.

Suggest why 1 g of silicon dioxide is **more effective** as a catalyst when used as nanoparticles rather than as a powder.

---

[3]

---

38 A student investigates the reaction between marble chips and hydrochloric acid.

She times how long it takes for all the marble chips to react.

Look at her results.

Experiment	Size of marble chips	Reaction time (s)	Mean rate of reaction (g/s)
1	large	240	8.33×10^{-4}
2	large	120	
3	large	100	2.00×10^{-3}
4	small	50	4.00×10^{-3}

Look at the student's results for experiment **2**.

Calculate the **mean rate of reaction** in experiment **2**.

Give your answer to **3** significant figures and in **standard form**.

Mean rate of reaction = ... g/s **[3]**

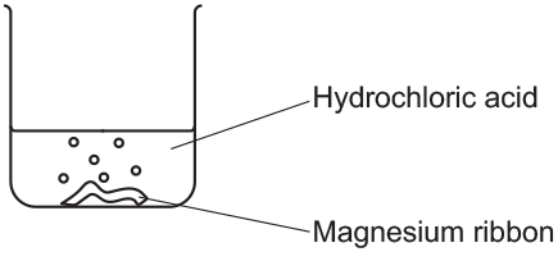
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39(a) A student investigates the reaction between magnesium and dilute hydrochloric acid, HC*l*.

The student adds magnesium ribbon to hydrochloric acid in a beaker, as shown in the diagram.



Magnesium chloride, $MgCl_2$, and hydrogen gas are made.

Write the **balanced symbol** equation for this reaction.

[2]

(b) *The student measures the time it takes for all the magnesium to react. This is the reaction time.

The student does five experiments.

This is the student's prediction:

"The smaller the volume of acid and the smaller the mass of magnesium, the shorter the reaction time."

Look at the student's results.

Experiment	Mass of magnesium used (g)	Volume of acid used (cm^3)	Concentration of acid (mol / dm^3)	Reaction time (s)
1	0.05	25	1.0	30
2	0.05	50	1.0	30
3	0.05	50	2.0	15
4	0.10	25	1.0	30
5	0.10	50	2.0	15

Describe and explain whether the student's results support his prediction.

Include ideas about the reacting particle model in your answer.

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[6]

(c) The student repeats experiment **1**. This time he uses acid at a **lower** temperature.

Explain, using the reacting particle model, **what happens to the rate of reaction** and **predict the reaction time** for this reaction.

[3]

(d) During chemical reactions, reactants are used up and the rate of reaction **decreases**.

Explain, in terms of particles, why the rate of reaction decreases.

---

[2]

40 A student investigates the reaction between zinc and dilute sulfuric acid.

He measures the time taken to collect 50 cm_3 of hydrogen gas. This time is 65 seconds.

The student investigates four substances which are possible **catalysts** for the reaction.

Substance	Appearance of substance	Time to collect 50 cm^3 of hydrogen (g)	Other observations
A	red-brown powder	19	red-brown powder remains
B	blue solid	15	colourless solution formed
C	red-brown lumps	65	red-brown lumps remain
D	white solid	65	colourless solution formed

Which substance, **A**, **B**, **C** or **D**, is a catalyst for the reaction?

Your answer ☐ **[1]**

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41 A student investigates the decomposition of hydrogen peroxide.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

0.2 g of oxygen gas is produced in the reaction.

The student uses 0.5 g of manganese(IV) oxide as a catalyst in the reaction.

How much manganese(IV) oxide remains at the end of the reaction?

A 0.2 g
B 0.3 g
C 0.5 g
D 0.7 g

Your answer ☐ [1]

42 A student investigates the decomposition of hydrogen peroxide.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

0.2g of oxygen gas is produced in the reaction.

The student uses 0.5 g of manganese(IV) oxide as a catalyst in the reaction.

How much manganese(IV) oxide remains at the end of the reaction?

A 0.2g
B 0.3g
C 0.5g
D 0.7g

Your answer ☐ [1]

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43 Enzymes are a type of catalyst.

Which of the following catalysts is an example of an enzyme?

A Amylase – a catalyst found in human saliva.
B Iron – a catalyst used in the Haber process.
C Manganese(IV) oxide – a catalyst used in the decomposition of hydrogen peroxide.
D Vanadium(V) oxide – a catalyst used in the Contact process.

Your answer ☐ [1]

44 The rate of reaction of marble chips with dilute hydrochloric acid depends on the surface area of the marble chips.

Which surface area of the marble chips gives the **highest** rate of reaction?

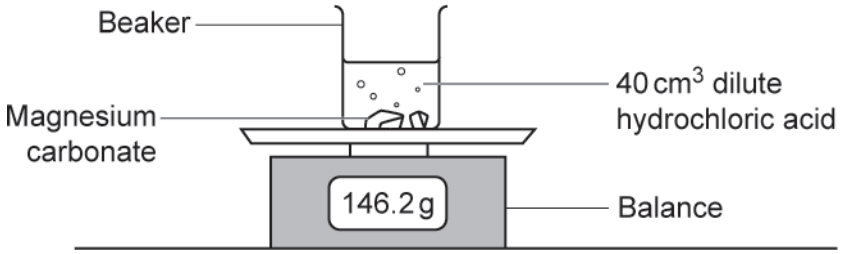
A $0.673\ mm^2$
B $1030\ mm^2$
C $2.18 \times 10^3\ mm^2$
D $4.98 \times 10^{-2}\ mm^2$

Your answer ☐ [1]

45(a) A student investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

She wants to find out how the concentration of the acid changes the rate of reaction.

Look at the apparatus she uses.



Carbon dioxide gas is given off in the reaction.

The student measures the loss in mass every 30 seconds for 5 minutes.

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Another student also investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

He also wants to find out how the **concentration** of the acid changes the rate of reaction. He uses a **different** method.

Describe the **method** he uses.

Include a **labelled diagram** of the setup of the apparatus he uses.

---

[5]

(b) Some students investigate the reaction between sodium thiosulfate and dilute hydrochloric acid.

They want to find out how **temperature** changes the rate of reaction.

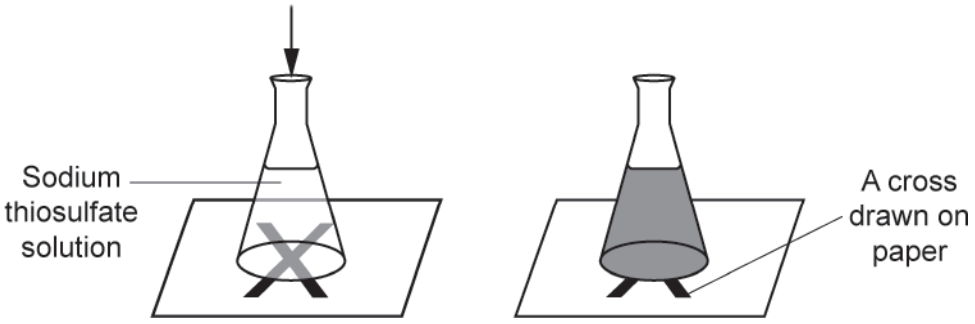
Look at the diagram of their experiment.

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Add dilute hydrochloric acid and start timing



A yellow solid is made during the reaction.

The students time how long it takes for the cross to disappear. This is the reaction time.

Look at their results.

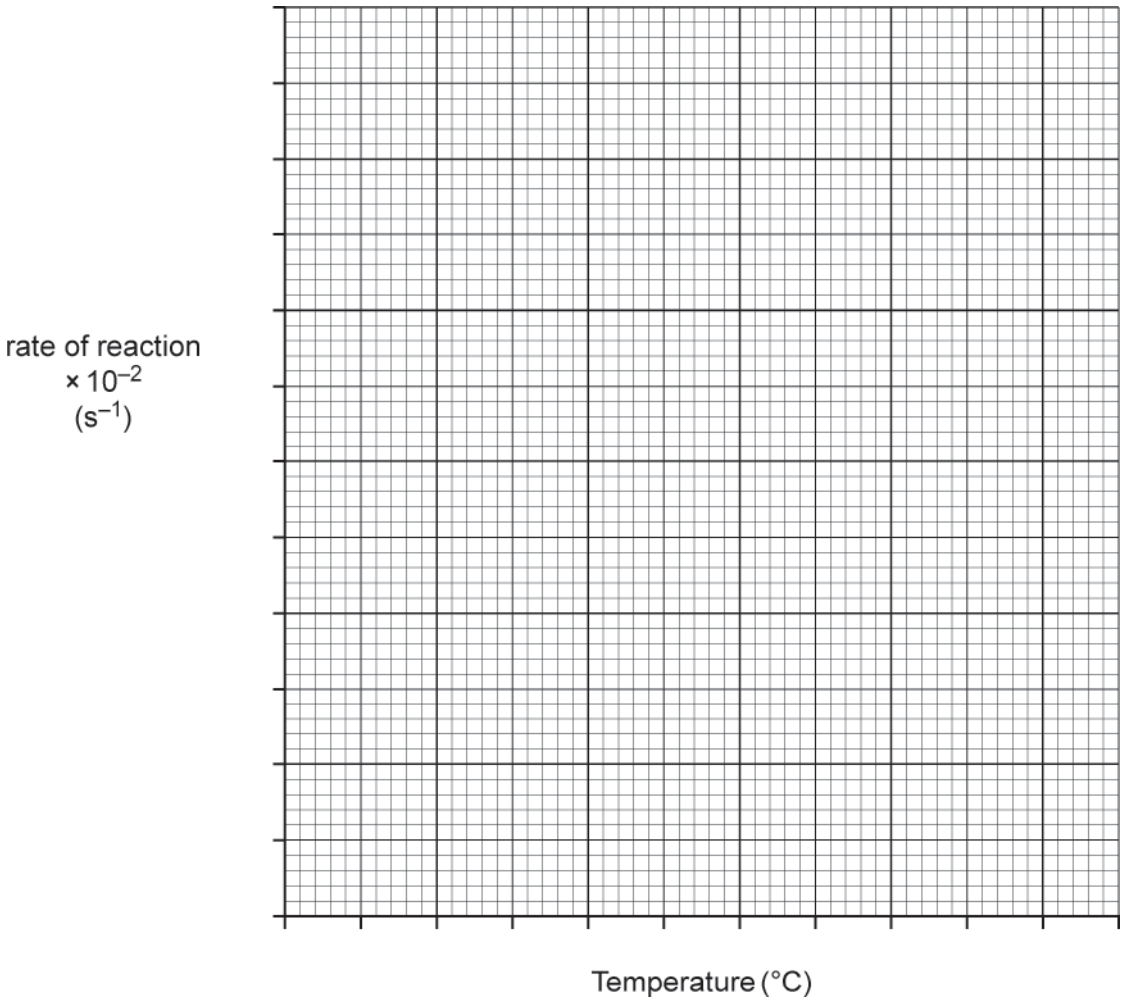
Temperature (°C)	Reaction time (s)	Rate of reaction (s^{-1})
10	140	7×10^{-3}
20	56	2×10^{-2}
30	34	3×10^{-2}
40	26	4×10^{-2}
50	22	5×10^{-2}

(i) Plot a graph of the results on the grid. Draw a line of best fit.

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[4]

(ii) What happens to the **rate of reaction** as the temperature increases?

[1]

(iii) Explain your answer to **(ii)**.

Use ideas about collisions between particles in your answer.

[3]

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46(a) A student investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

She wants to find out how the concentration of the acid changes the rate of reaction.

Fig. 18.1 shows the apparatus she uses.

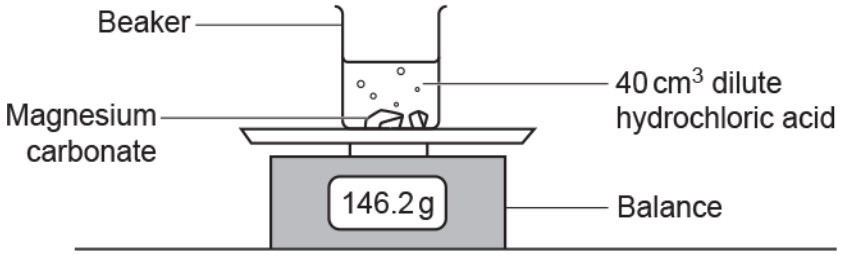


Fig. 18.1

Carbon dioxide gas is given off in the reaction.

The student measures the loss in mass every 30 seconds for 5 minutes.

Another student also investigates the rate of reaction between dilute hydrochloric acid and magnesium carbonate.

Fig. 18.2 shows diagrams of some of the apparatus he uses.

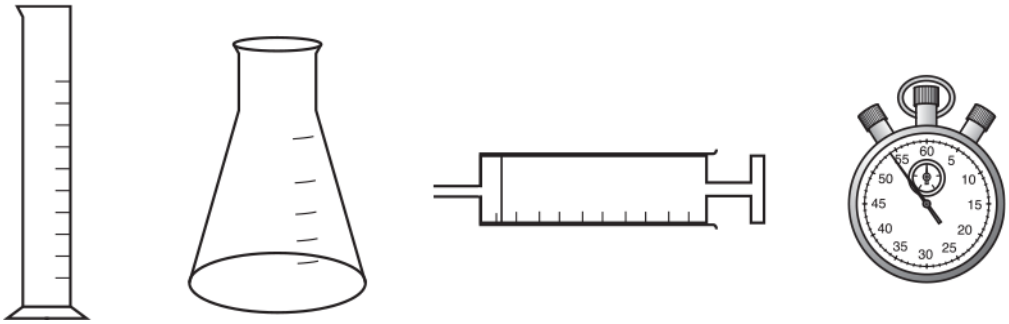


Fig. 18.2

The student also wants to find out how the **concentration** of the acid changes the rate of reaction.

Describe the **method** he follows using the apparatus in **Fig. 18.2**.

Include a **labelled diagram** of the set-up of the apparatus he uses.

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[4]

(b) Some students investigate the reaction between sodium thiosulfate and dilute hydrochloric acid.

They want to find out how **temperature** changes the rate of reaction.

Fig. 18.3 is a diagram of their experiment.

Add dilute hydrochloric acid and start timing

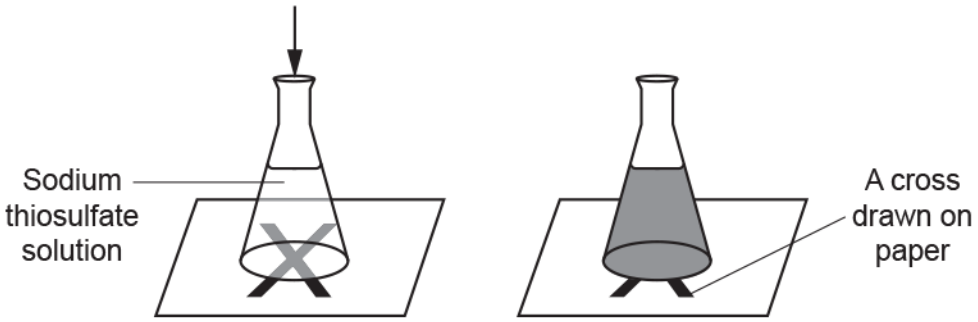


Fig. 18.3

A yellow solid is made during the reaction.

The students time how long it takes for the cross to disappear. This is the reaction time.

Look at their results.

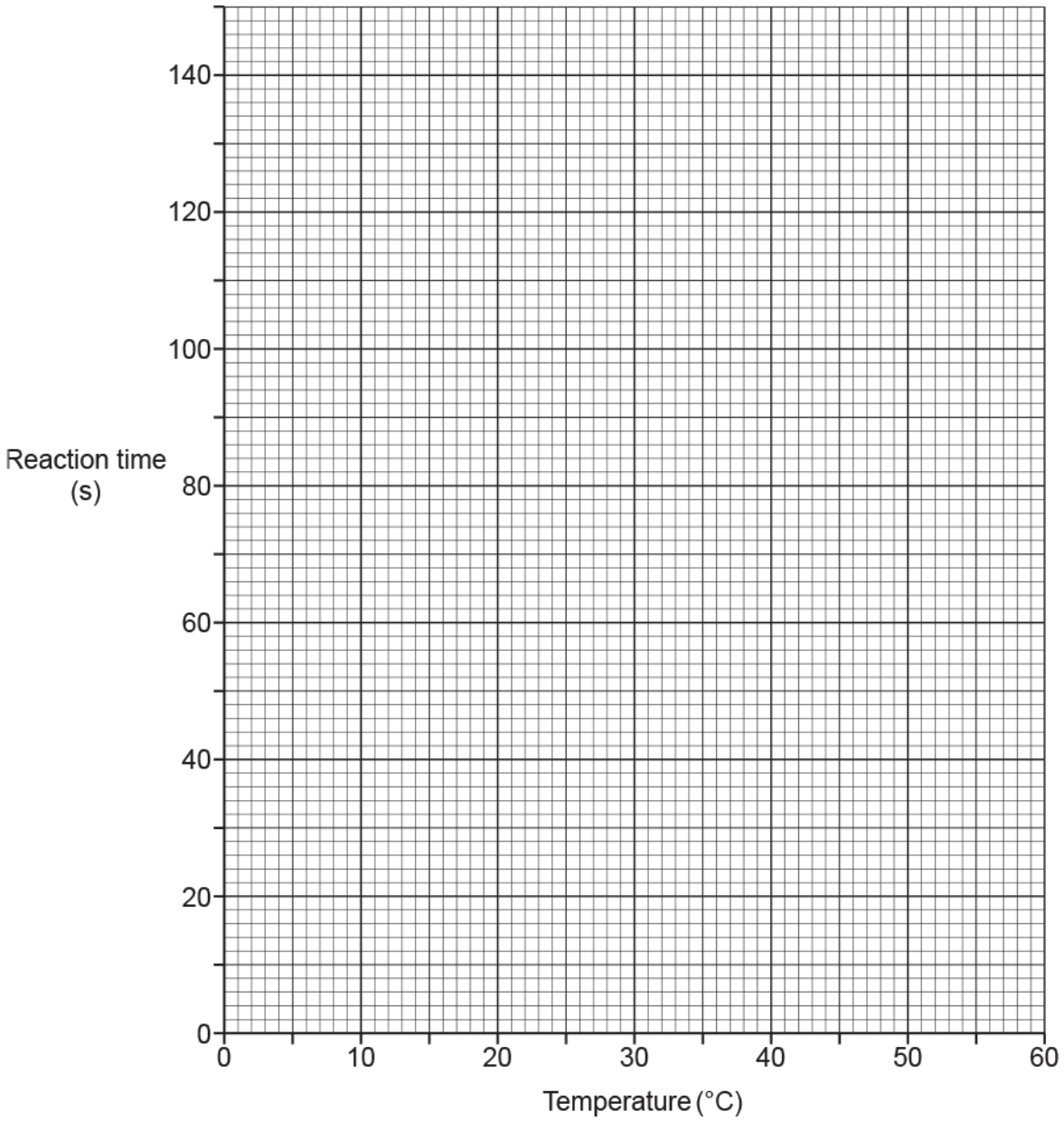
Temperature (°C)	Reaction Time (s)
10	140
20	56
30	34
40	26
50	22

(i) Plot a graph of the results on the grid. Draw a line of best fit.

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[3]

(ii) What is the reaction time at **25 °C**?

Reaction time = ... s **[1]**

(iii) What happens to the **rate of reaction** as the temperature increases?

[1]

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(iv) Explain your answer to **(iii)**. Include ideas about collisions between particles in your answer.

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[2]

END OF QUESTION PAPER

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